M.R.P. 981
S.C. 11/210
30th April, 1956.

Average height of the standard isobaric surfaces over the area from the North Pole to 55°N in July.

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H. Heastie.

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AIR MINISTRY

METEOROLOGICAL RESEARCH COMMITTEE

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1. Introduction

This paper is essentially a continuation of M.R.P. 918(1). In the latter paper the decision to start the revision of Geophysical Memoir 85 - Upper Winds over the World - by constructing circumpolar charts of the standard isobaric surfaces, was explained and the charts for January were presented. The present paper shows a similar set of average contour and thickness charts for July.

2. The data

Data for the same fixed period, 1949-53, were used and the sources are listed in the earlier paper. The labour of extraction was eased by the receipt of further micro-film data for Norwegian stations from Det Norske Meteorologiske Institutt, Oslo and of manuscript data for Alaska and the Aleutians from U.S. Weather Bureau.

3. Method of constructing the charts

(1) General. The method employed was the same as that used in the construction of the January charts, although there was one slight complication over Siberia. In general, the data available from the U.S.S.R. were even scantier than in January and for July, 1949 there were no data at all from Siberia. For this month the monthly mean 500 mb. contour chart published in the monthly supplement to the German Daily Weather Report (2) was accepted over Siberia and the 700-500 mb. thickness chart constructed over this area by correlating the 700-500 mb. thickness with the 500 mb. contour height along the meridians 20°E, 40°E, ... 180°E for the four years 1950-53. As the grid values obtained fitted in reasonably well with the rest of the chart drawn from data and as the nine values obtained for the pole lay within a ten metre range the method was regarded as satisfactory. The 500-300 mb. thickness chart and the 300 mb. temperature chart were similarly computed by correlating the 500-300 mb. thickness with the 700-500 mb. thickness and the 300 mb. temperature with the 500-300 mb. thickness. A further check on the drawing over the U.S.S.R. was obtained by comparing the average 300 mb. temperature chart with that in the memoir on upper air temperature (3).

(2) Effect of solar radiation. For a large part of the area covered by the chart no night time ascents were available and the effect of solar radiation on the various types of radiosondes used by the different countries had to be considered. It has not proved possible to avoid this difficulty completely. With one exception, noted below, 0300 G.M.T.

/data

data were used since, in most areas, these were the only data readily available. For the U.S.S.R. the 0300 G.M.T. ascents are made in daylight and unfortunately very little, if anything, is known about the characteristics of the Russian instrument. Russian data were available up to 300 mb. only and at this level there was some indication that the temperature reading was 1-2°C. too high. Above 300 mb., temperature lapse rates from the memoir on upper air temperature were used and these again may be subject to error for similar reasons. Data from U.S.W.B. stations and the joint U.S.-Canadian stations in northern Canada are corrected (from March, 1950) for the effect of solar radiation and the 0300 G.M.T. data were accepted. No radiation correction is made at Canadian stations, at some of which a U.S. type of radiosonde is used and at others a Canadian instrument. The data from the latter group of stations were modified in the light of a paper by Henry (4) who estimated corrections to obtain agreement between Canadian-instrument stations and American-instrument stations corrected for radiation. Of the Canadian stations using the U.S. type of radiosonde the majority are in darkness at 0300 G.M.T. The data from those in daylight at 0300 G.M.T. were corrected approximately by reference to the U.S.W.B. publication (5) on the subject. The weather ships A, B, C, I and J and the British stations, with the partial exception of Lerwick, are in darkness at 0300 G.M.T. The ascents from the Scandinavian stations on the other hand were made in daylight. The Danish and Finnish data are corrected while the Norwegian and Swedish are not. No attempt was made to apply any systematic correction to the latter. At a small group of stations in the Aleutians no radiation correction is applied and for these stations only 1500 G.M.T. data were used.

4. The charts

The July contour charts show some marked differences from those for January. In January there is mainly westerly flow in the troposphere with considerable asymmetry about the pole. The very cold arctic winter stratosphere leads to a thermal pattern which reinforces this flow so that the January charts present a picture of mainly westerly flow increasing with height and becoming almost symmetric about the pole at the 100 mb. level. In July there is again mainly westerly, though much weaker, flow in the troposphere (Figs. 1, 2 and 3). The 700-500 mb. and 500-300 mb. thickness charts (Figs. 7 and 8) both show centres of low thickness over northern Canada and the main axis of the tropospheric flow is tilted southwards with height along the 90°W meridian. The 300-200 mb. thickness chart (Fig.9) where the layer is partly in the troposphere and partly in the stratosphere shows a rather confused pattern. In the region considered the tropopause is everywhere below the 200 mb. surface and the very warm arctic summer stratosphere is reflected in the 200-150 mb. and 150-100 mb. thickness charts (Figs.10 and 11) which both show an easterly thermal centred on the pole. The resulting contour charts show a mainly westerly flow over Eurasia at all levels, increasing up to 200 mb. (Fig.4) decreasing again at 150 mb. (Fig.5) and at 100 mb. (Fig.6) and spreading across the pole to give an easterly flow over extreme northern Canada and Greenland. Over the Canadian sector of the chart the centre of low contour height is transferred southwards from about 87°N at 700 mb. to about 68°N at 100 mb. and lies between the 70°W and 90°W meridians. The flow round this low centre increases generally up to 300 mb. and above 200 mb. decreases again to less than 15 kt. everywhere. Hence, up to 100 mb., where the January charts show increasing symmetry with height, the July charts become more asymmetric with height. Temperature lapses 100-25 mb. shown on the Air Weather Service charts (6) suggest that from about 25 mb. upwards the circulation is again tending towards symmetry round the pole with a contour high moving northwards over central Siberia towards the pole and the Canadian low centre moving southwards and being absorbed.

One interesting feature arising out of the symmetry of the thickness

/pattern

pattern and the asymmetry of the contour pattern in the stratosphere may be mentioned here. Over a large area of the chart north of the Arctic Circle the flow in the stratosphere (Figs.4, 5 and 6) is directly across the thickness pattern (Figs.10 and 11). Neither the flow in the troposphere (Figs.2 and 3) nor the tropopause pressure chart (3) suggests any appreciable vertical motion of the atmosphere in this area and the implied temperature changes are presumably due to radiative effects. For both the layers 200-150 mb. and 150-100 mb. the heating of the air moving poleward from 70-75°N appears to be of the order of 0.5°C./day over 2-4 days. The stratosphere over this area is in continuous sunlight during the whole of July, but no attempt has been made to estimate whether variation in solar altitude or in ozone concentration could account for this heating.

It may be argued that average contour lines crossing average thickness lines do not necessarily imply flow across the thickness lines on any single occasion. Indeed, it is possible to construct a series of wind and temperature systems, such that for each system separately, the flow is along the thickness lines, while the mean flow is across the mean thickness lines. However, to produce this anomaly, too many systems which violate the Dines relationships between troposphere and stratosphere have to be used, and it is known that these relationships hold for arctic regions in July (7).

References

(1) Heastie, H. Average height of the standard isobaric surfaces over the area from the North Pole to 55°N in January. Meteorological Research Papers, Air Ministry, London, No. 918, 1955.

(2) Die Grosswetterlagen Mitteleuropas. Deutsche Wetterdienst, Bad Kissingen, Germany.

(3) Goldie, N., Moore, J.G. and Austin, E.E. Upper air temperatures over the world. Geophys. Mem., London (in the press).

(4) Henry, T.J.G. A comparison of mean temperatures obtained with Canadian and American types of radiosonde. Department of Transport, Meteorological Division, Toronto, Circular 2041, 1951.

(5) Washington, U.S. Weather Bureau. Manual of Radiosonde Observations, Circular P (Addendum), 1950.

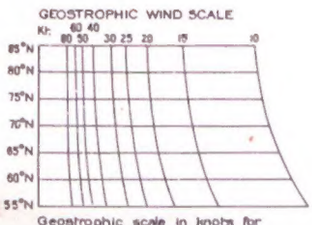
(6) Washington, U.S. Air Weather Service. Mean monthly maps of 300, 200, 100, 50 and 25 mb. surfaces over North America. Technical Report No.105-107, Washington, 1953.

(7) Bannon, J.K. and Gilchrist, A. Variation of temperature in the troposphere and lower stratosphere. Quart. J.R. Met. Soc., 82, p.58, 1956.

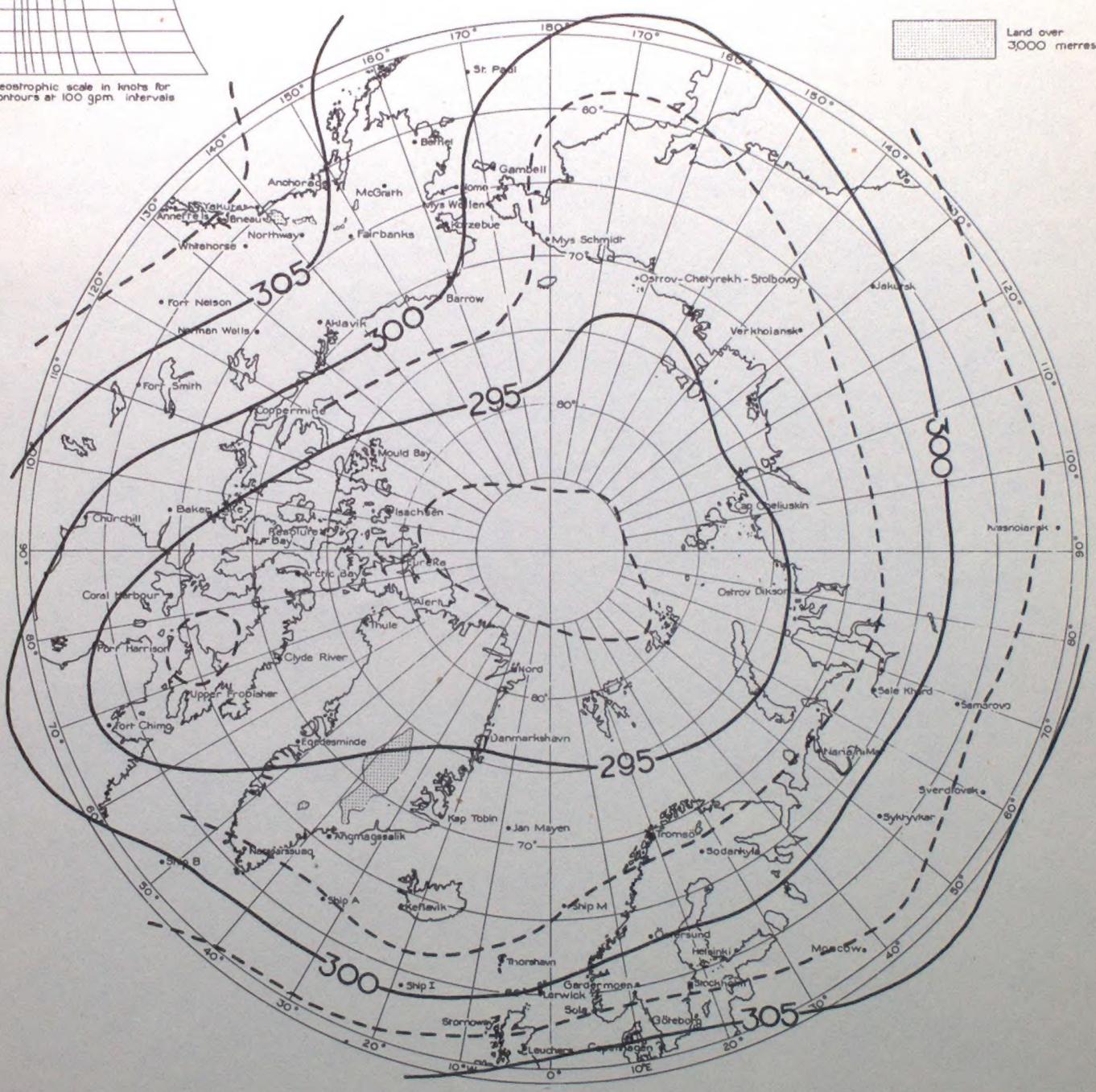
AVERAGE 700 mb. CONTOURS

M.R.P. 981

JULY 1949 - 1953



Geostrophic scale in knots for contours at 100 gpm. intervals



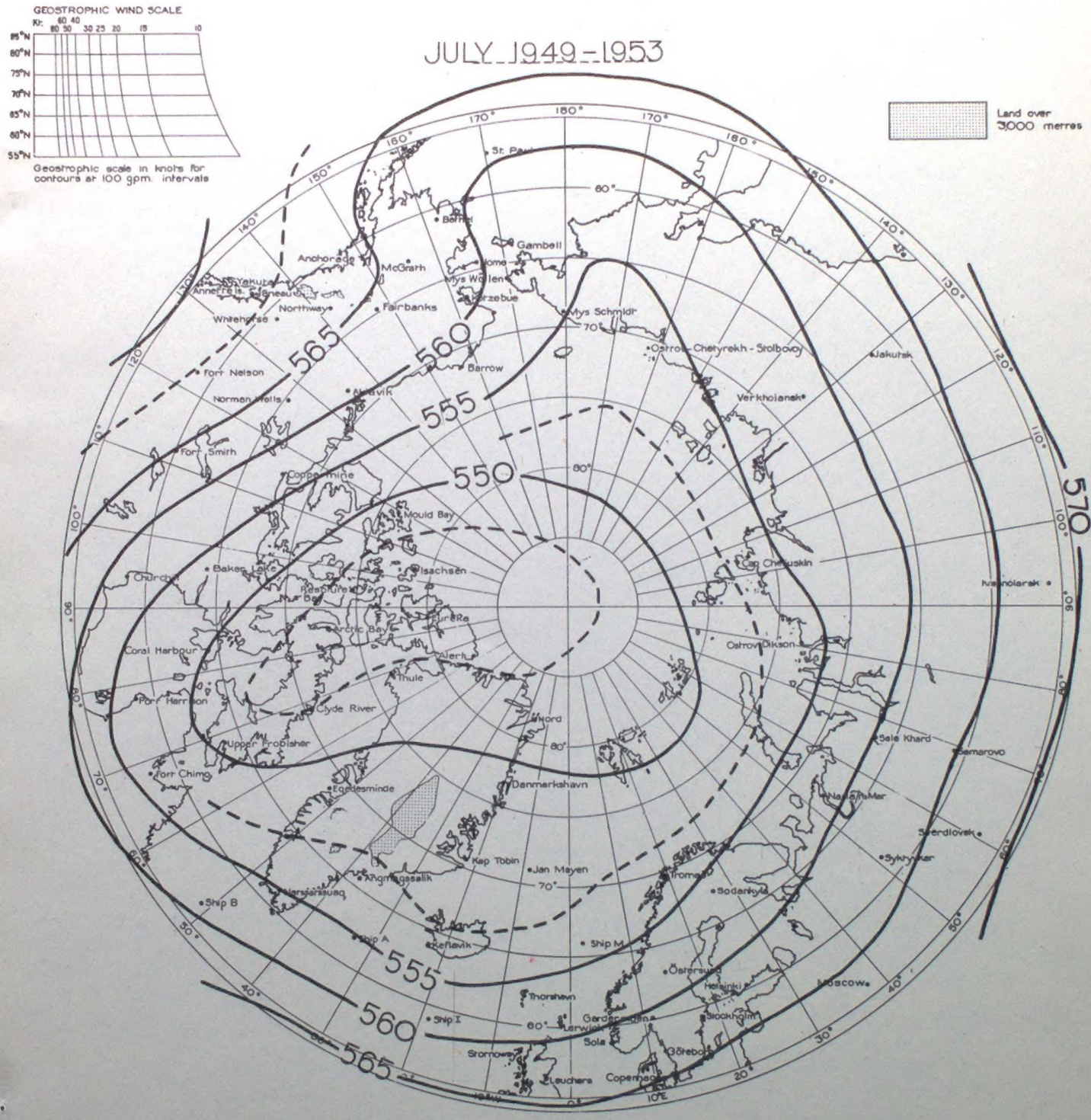
Height in dekametres

Fig. 1

Upper Air Branch (M.O.23)

AVERAGE 500 mb. CONTOURS

M.R.P. 981



Height in dekametres

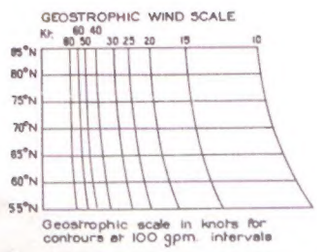
Fig. 2

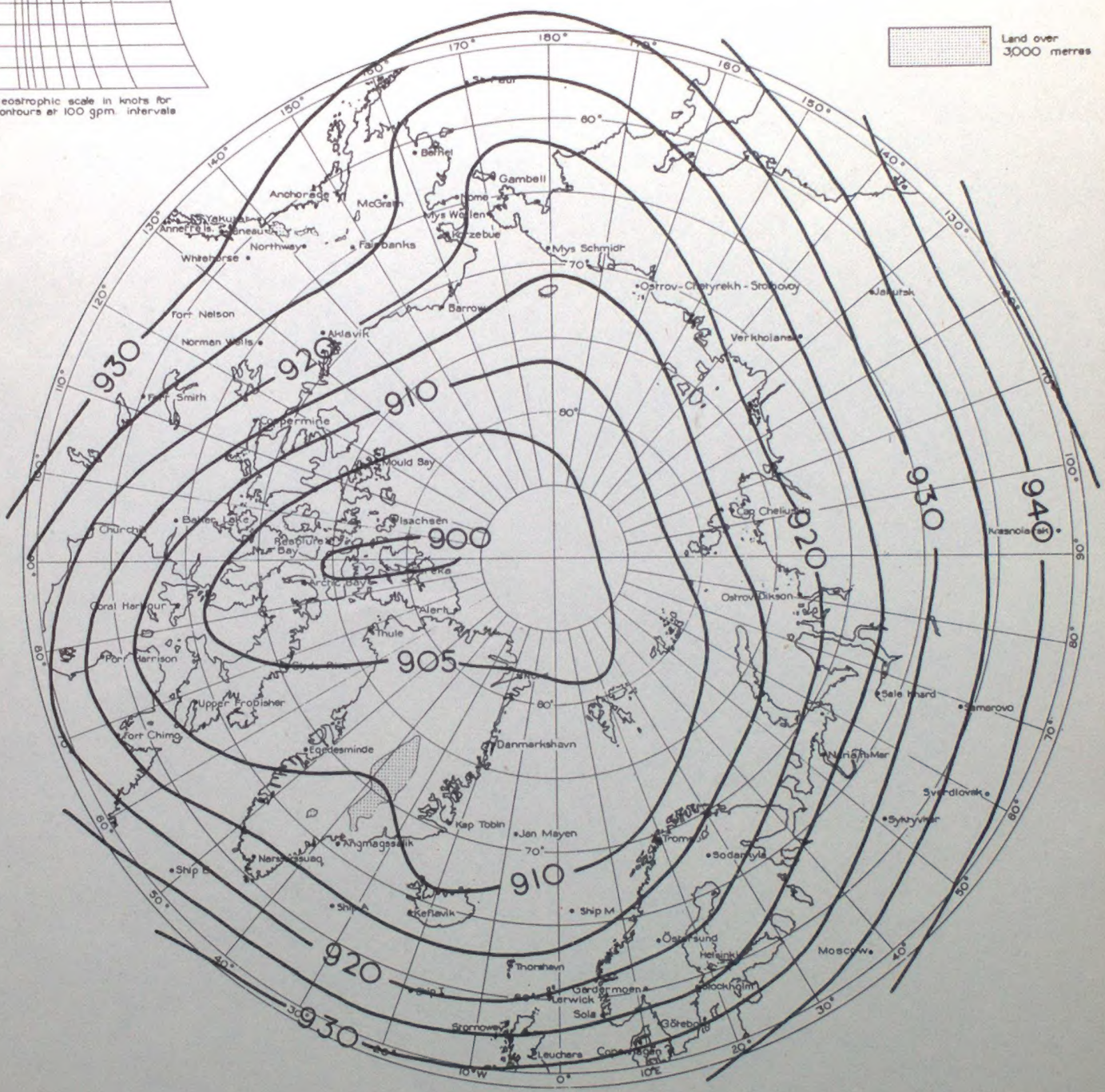
Upper Air Branch (M.O.23)

AVERAGE 300 mb. CONTOURS

M.R.P. 981

JULY 1949–1953





Height in dekametres

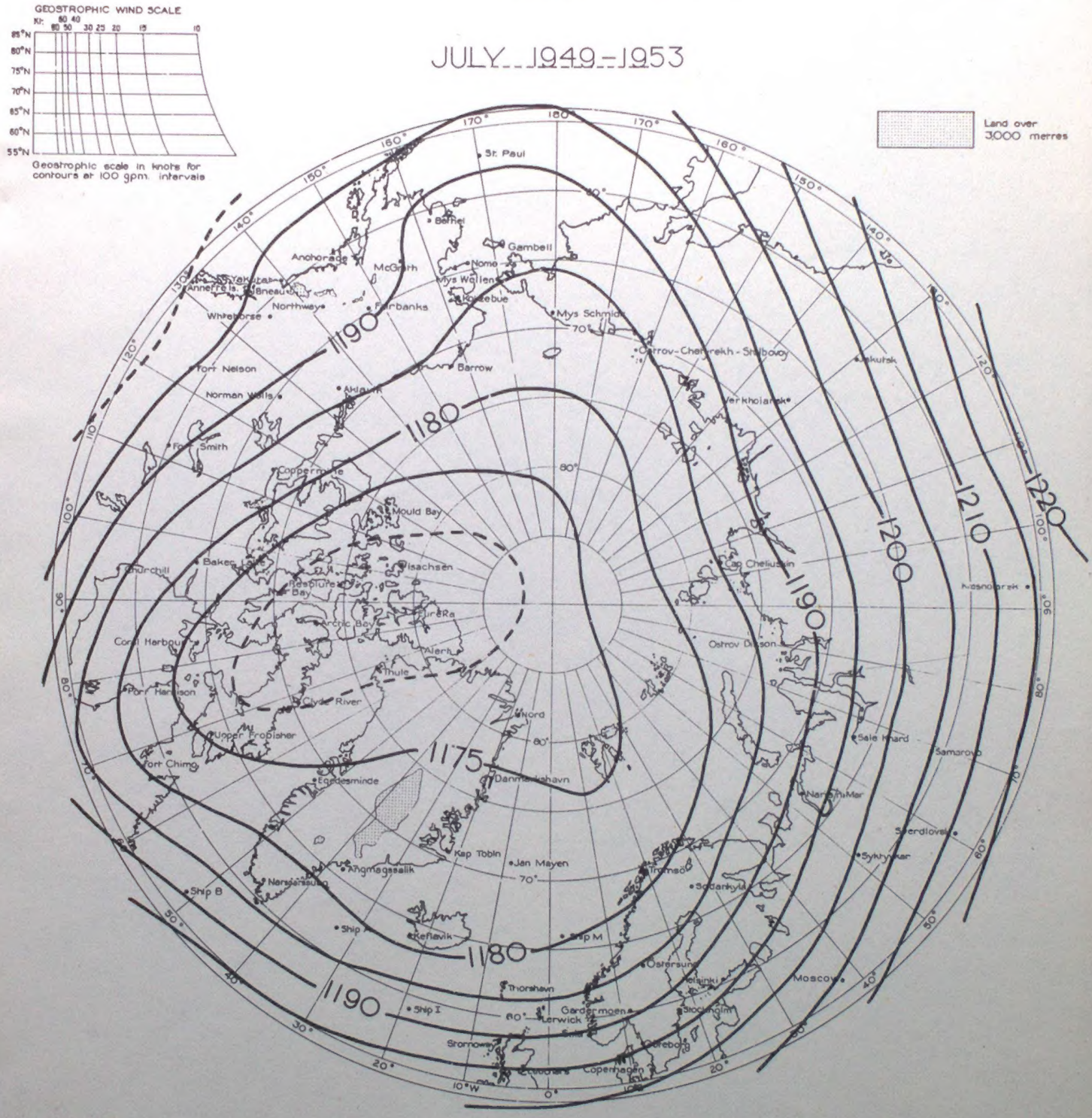
Fig. 3

Upper Air Branch (M.O.23)

AVERAGE 200 mb. CONTOURS

M.R.P. 981

JULY 1949-1953



Height in dekametres

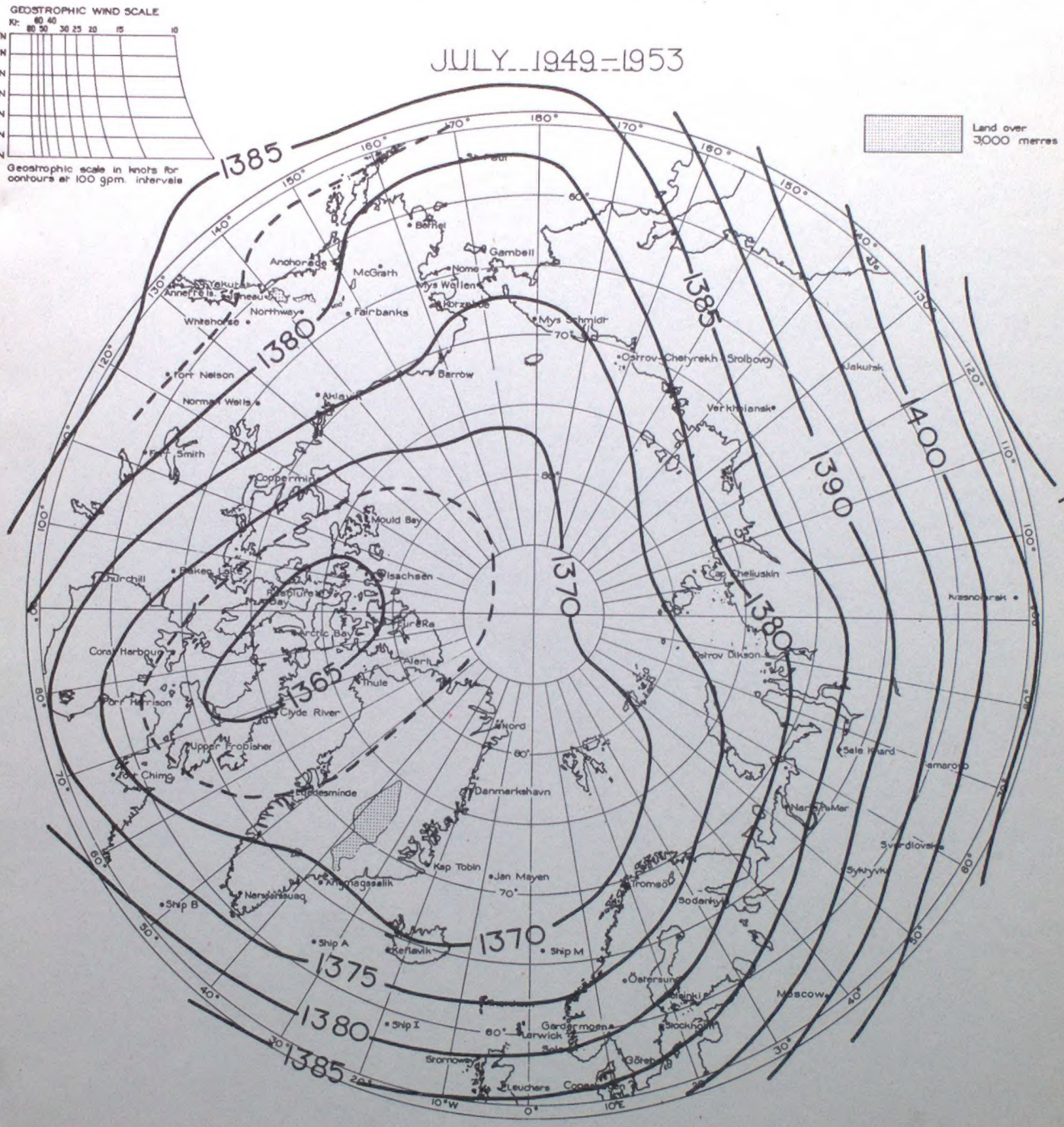
Fig. 4

Upper Air Branch (M.O23)

AVERAGE 150 mb. CONTOURS

M.R.P. 981

JULY 1949–1953



Height in dekametres

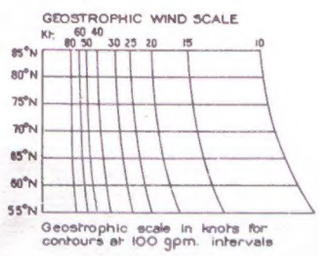
Fig. 5

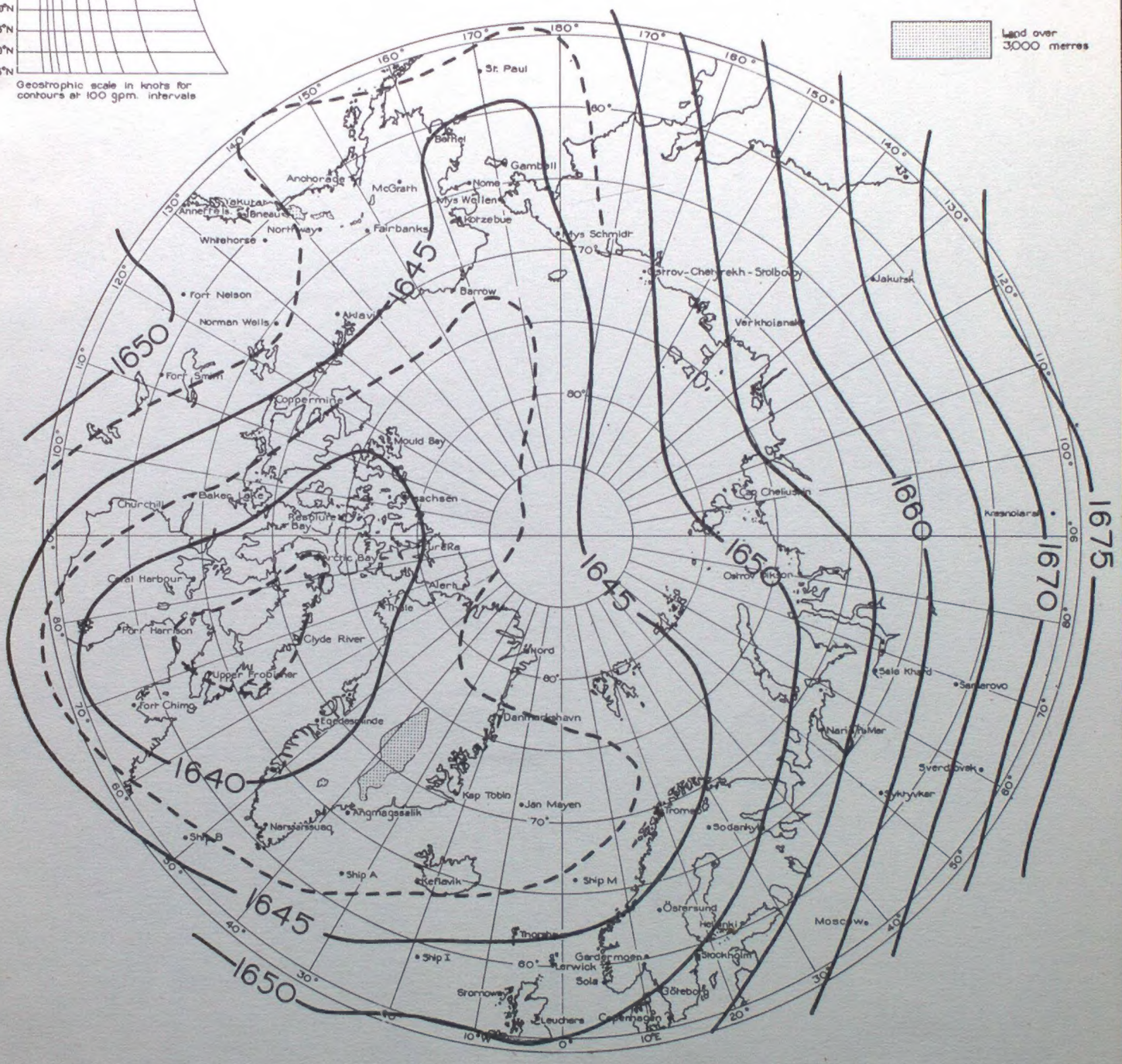
Upper Air Branch (M.O.23)

AVERAGE 1000 mb. CONTOURS

M.R.P. 981

JULY 1949-1953





Height in dekametres

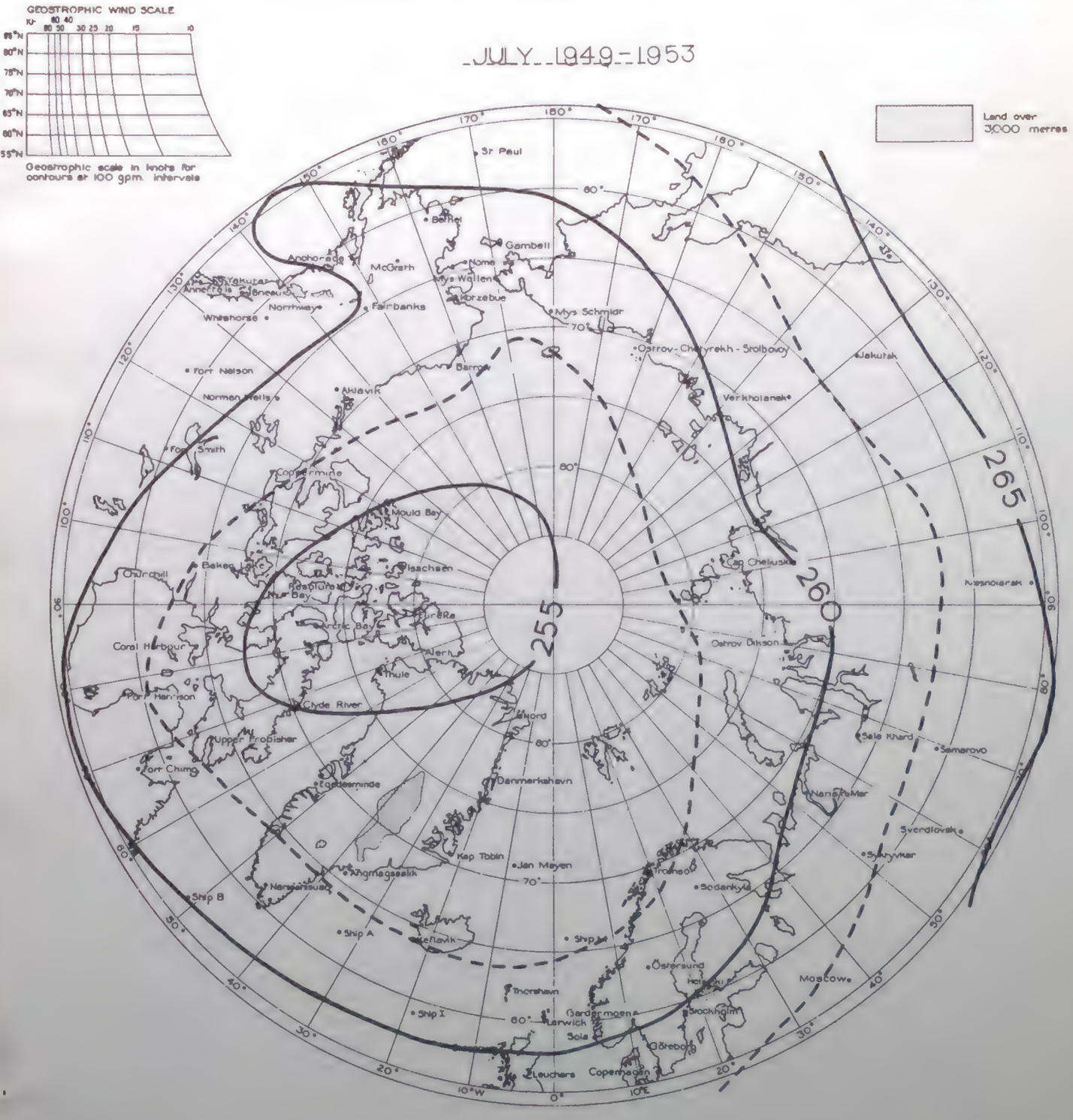
Fig. 6

Upper Air Branch (M.O.23)

AVERAGE 700–500 mb. THICKNESS

M.R.P. 981

JULY 1949–1953



Height in dekametres

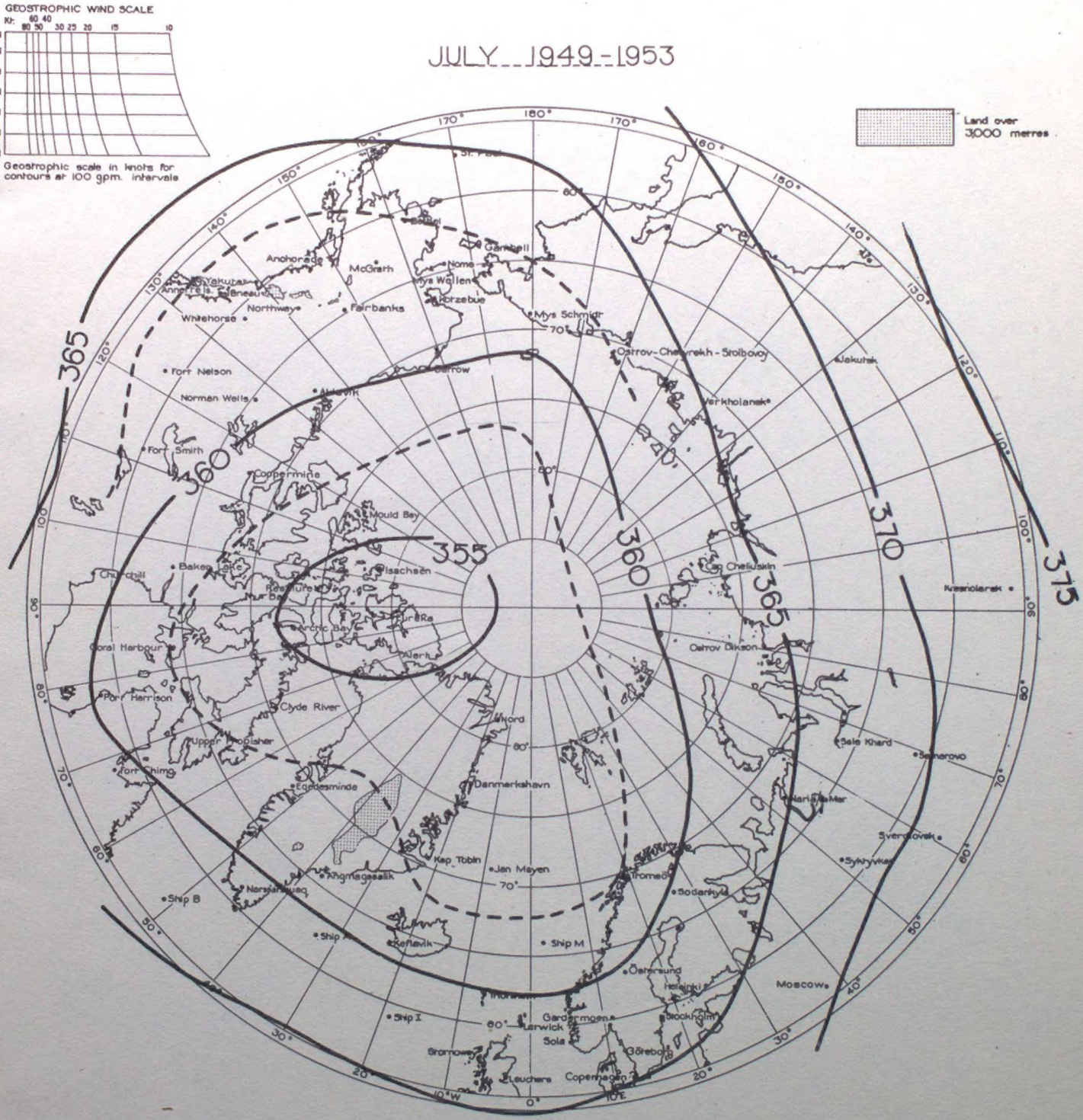
Fig. 7

Upper Air Branch (M.O.23)

AVERAGE 500-300 mb. THICKNESS

M.R.P. 981

JULY 1949-1953



Height in dekametres

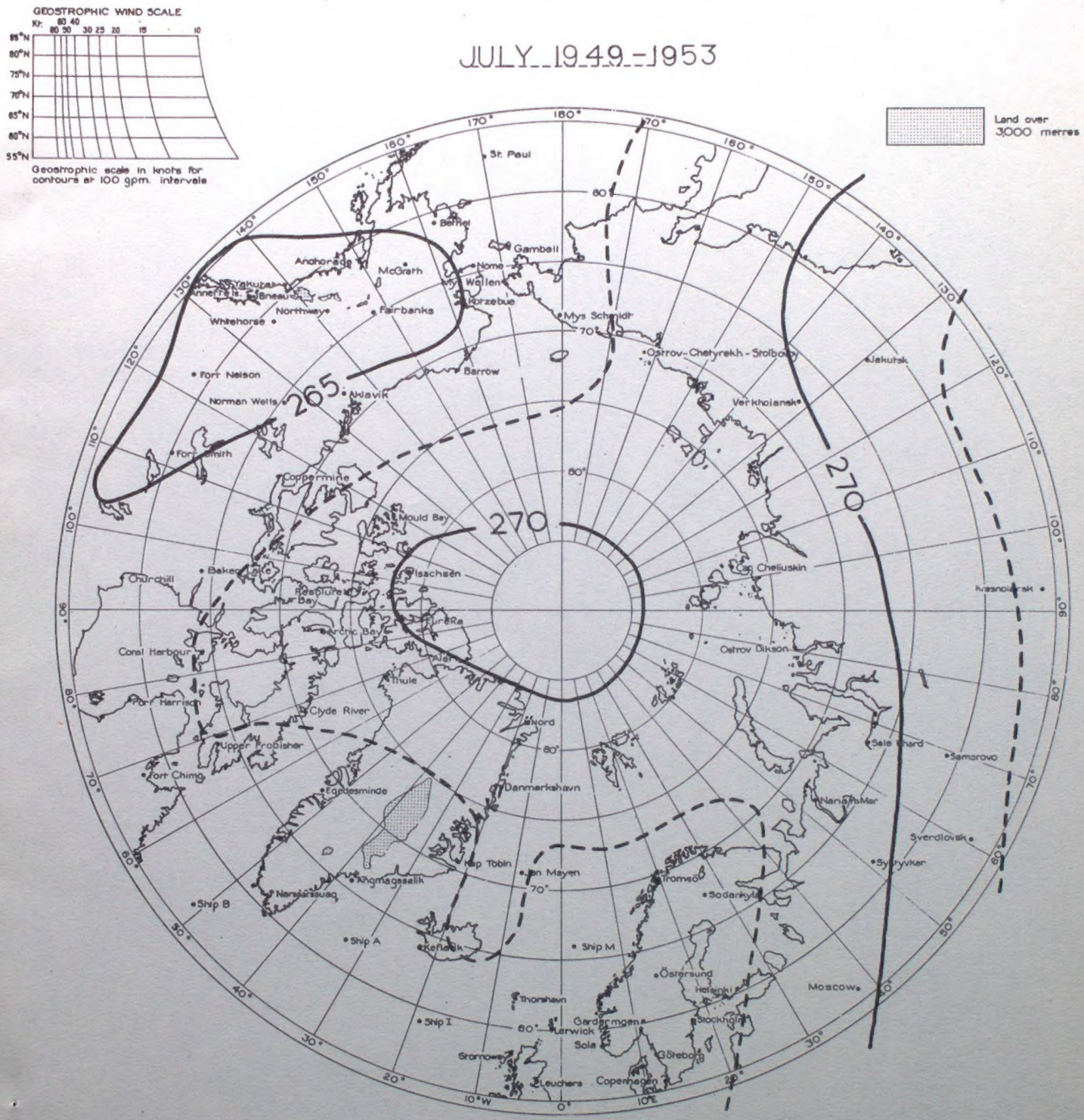
Fig. 8

Upper Air Branch (M.O.23)

AVERAGE 300-200 mb. THICKNESS

M.R.P. 981

JULY 1949-1953



Height in dekametres

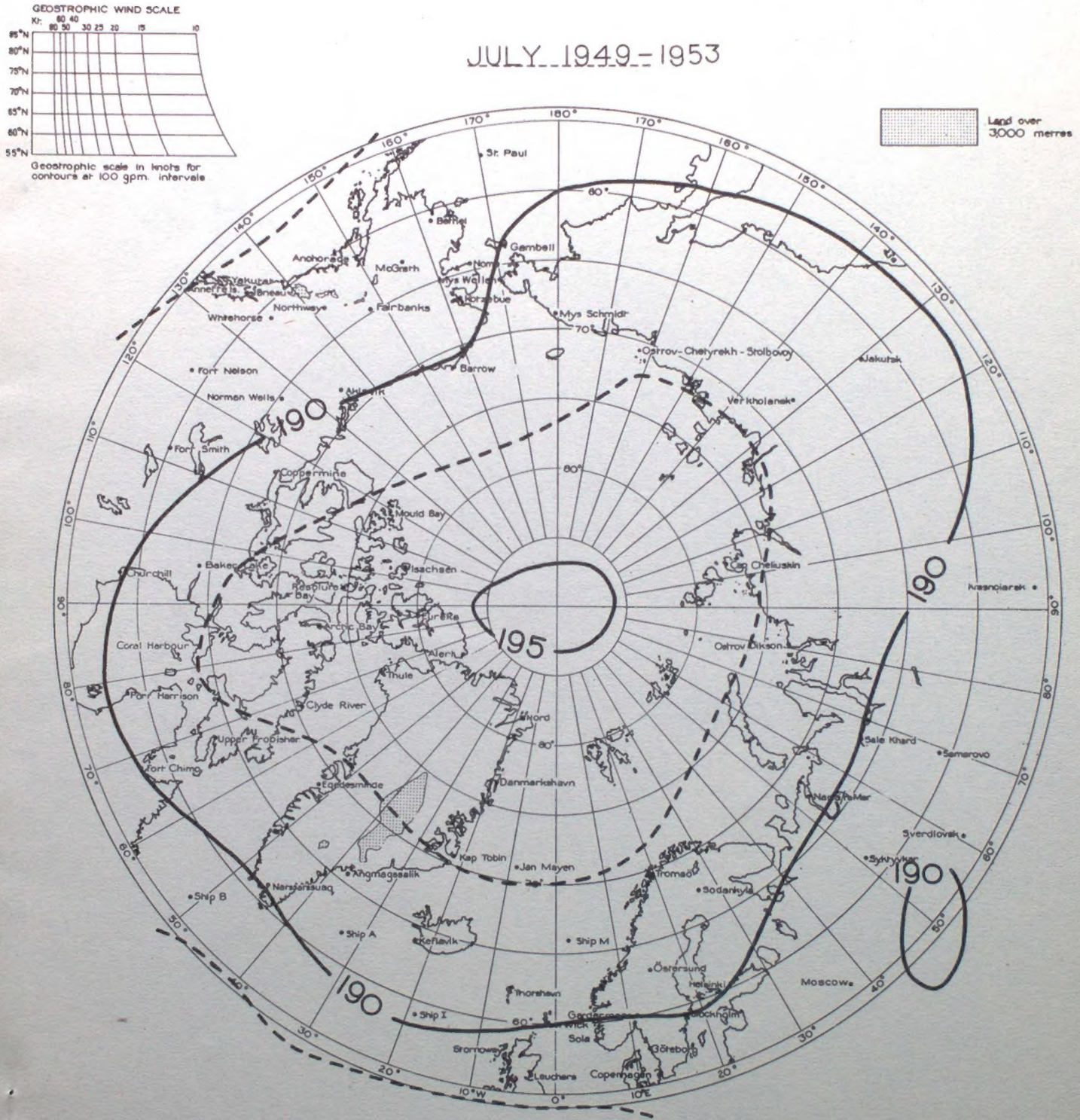
Fig. 9

Upper Air Branch (M.O.23)

AVERAGE 200-150mb. THICKNESS

M.R.P. 981

JULY 1949-1953



Height in dekametres

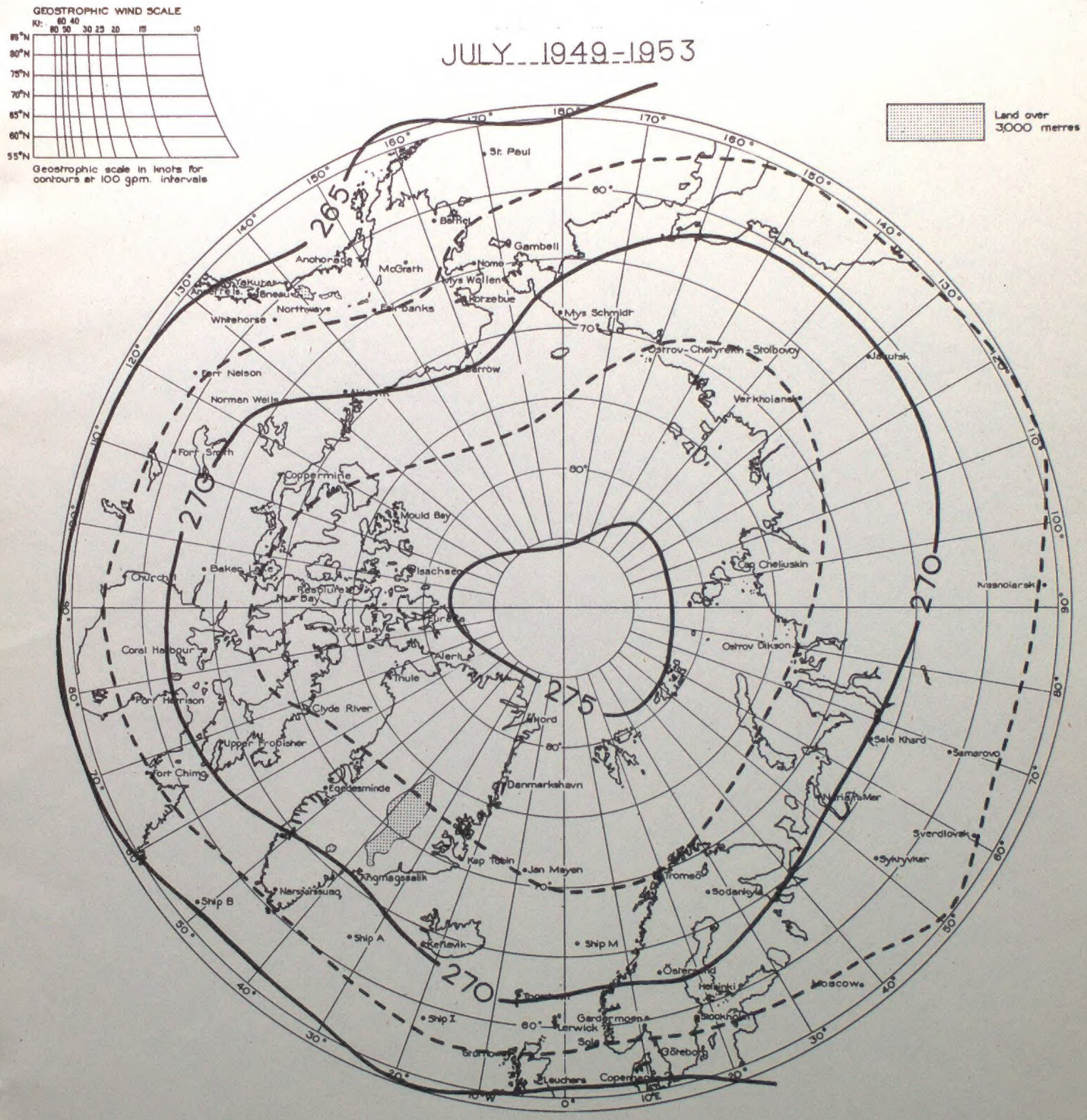
Fig 10

Upper Air Branch (M.O.23)

AVERAGE 150-100 mb. THICKNESS

M.R.P. 981

JULY 1949-1953



Height in dekametres

Fig. 11

Upper Air Branch (M.O.23)